Bizot gives the average diameter of the aorta at its origin as 7 cm. in males and 6.4 cm. in females. Beneke gives the average in youth as 6 cm. The authors mentioned found in the narrow aortas a circumference of 4.2 to 5.2 cm.

BIBLIOGRAPHY.

1. Osler. Practice of Medicine.
2. Flint. Practice of Medicine, 1886.
3. Senator. Die Erkrankungen d. Nieren, Nothnagel's Pathologie und Therapie.
4. Heubner. Ueber Chronische Nephritis im Kindersalter, Berlin, 1897.
5. Ashby and Wright. Text-book, 1900.
6. Gutherie. Chronic Interstitial Nephritis in Childhood, Lancet, 1897, vol. i.
7. Steiner and Neuretter. Prager Vierteljahr., Bd. cv. p. 74.
8. Brill and Libman. A Contribution to the Subjects of Chronic Interstitial Nephritis in the Young, Journal of Experimental Medicine, 1889, vol. iv.
9. Heubner. Loc. cit
10. Epstein. Prager med. Wochenschr., 1881, No. 33.
11. Koplik. Nephritis Complicating Gastroenteritis of Infants, Medical Record, April, 1899.
12. Henoch. Vorlesungen über Kinderkrank., Berlin, 1895.
13. Holt. Archives Pediatrics, April, 1892.
14. Filia. Review, Medical Record, May, 1903.
15. Perl. Berl. klin. Wochenschr., 1893, No. 28.
16. Mettenheimer. Jahrb. f. Kinderheilk., Bd. xxxii., S. 383.
17. Freeman. Nephritis of Influenza, Transactions of the Pediatric Society, 1892.
18. Weigert. Volkmann's Saml. klin. Vorträge, 1879, Nos. 162, 163.
19. Baginsky. Lehrbuch der Kinderkrank., Berlin, 1896.
20. Westphal. Berl. klin. Wochenschr., 1890, No. 29.
21. Arnold. Ziegler's Beiträge, Bd. viii.
22. Sutherland and Walker. British Medical Journal, 1903, vol. i. p. 959.
23. Dickinson. Diseases of Kidney, London, 1877, vol. ii.
24. Pel. Zeitschr. f. klin. Med., 1899.
25. Romme. Le presse médical, December 23, 1899.
26. Simnitzky. Ueber haufigkeit von Arterio-sclerotischen Veranderung in der Aorten junglicher Individuen, Zeitschr. f. Heilkunde., 1903, Bd. xxiv.
27. Ballantyne. Manual of Antenatal Pathology, 1902.
28. Marfan. Semaine méd., 1901, No. 13.
29. Sanne. Jahrb. f. Kinderheilk., Bd. xxv. p. 221.
30. Lancereaux. Monograph, Paris. Cited by Senator.
31. Besancon and Poillon. Paris, 1889. Cited by Senator.

KERNIG'S SIGN:

WITH REPORT OF CASES WHERE THE ANGLE HAS BEEN ACCURATELY DETERMINED.

By Joseph L. Miller, M.D.,
of Chicago.

Kernig, on September 21, 1882, read a paper before the St. Petersburg Medical Society on the presence of a sign which he considered pathognomonic for meningitis and which has since been known as Kernig's sign. This sign consists in inability to extend the leg fully when the thigh is at right angles to the trunk. Kernig made the test by having the patient sit on the edge of the bed with legs overhanging and then attempting to extend the legs. Osler first called attention to the fact that the sign could be elicited by having the patient lie on his back, and then, after flexing the thigh on the trunk to a right angle, an attempt is made to extend the leg on the thigh. This is a more satisfactory position, as it enables us to determine the angle with greater ease, and even very sick patients are not inconvenienced. Rudolph recommended making the test by first fully extending the leg, then flexing the thigh on the pelvis and measuring the angle at the hip, as by doing this only one angle need be gauged, while in the original method the thigh must first be placed at right angles to the trunk and then extend the leg. This I believe is an unnecessary refinement, as it is not essential that the angle of the thigh to the trunk be exactly a right angle, but approximately so, a point which can be sufficiently gauged by the eye; and, second, on account of the more irregular contour of the parts at the hip, it is more difficult to measure the angle with an instrument than it is at the knee. In the normal individual the leg can be almost completely extended when the thigh is at right angles to the trunk. Kernig reported that in case the sign was positive, the angle was about 135 degrees, but might reach 90 degrees, and since then the generally accepted view has been that an angle of 135 degrees or less is a positive Kernig. He called especial attention to the fact that in a patient with positive signs the leg could be completely extended, if the precaution was not taken to place the thigh at approximately a right angle to the trunk. He also reported that the sign might be present in the arms. He considered that this was an early and constant sign in meningitis, often persisting until the patient was well along in convalescence. His conclusions were based upon the examination of 15 cases of meningitis, the diagnosis being confirmed in 8 by autopsy. Thirteen of these cases were of the cerebrospinal form, 1 tubercular, and 1 suppurative. He also obtained the sign in spinal caries, pachymeningitis hemorrhagica, localized meningitis from otitis media, 1 case of hyperæmia of the meninges which he reports was possibly a beginning tuberculosis, chronic leptomeningitis, and a slight Kernig in a case of œdema of the pia.

Kernig's paper did not excite much attention. The first published confirmation of his results was made by Friis, in 1887, and again in 1892. Since then numerous reports have been made. All of these have emphasized the diagnostic value of the sign, and yet many of the recent works on medicine, neurology, or diagnosis fail to mention the sign; others merely refer to it without commenting on its value. None of these works report the various conditions, besides meningitis, where the sign is present or give accurate information as to what degree of flexor contraction constitutes the sign.

The lack of general knowledge of the subject is due, in part, to its unreliability. However, we have comparatively few signs which can be looked upon as pathognomonic, and lack of constancy merely lessens the value of the test, provided we are familiar with the source of error, and thus give it the proper weight.

Herrick reported 19 cases of meningitis: 9 cerebrospinal, 2 pneumococcus, 7 tubercular, 1 syphilitic. In 2 cases, 1 probably tubercular, the other following a pneumonia and associated with otitis media, the sign failed. Both of these cases were children, aged three and four years respectively, and the test was only made shortly before death, which may account for the result, as it has been noted that the rigidity of the neck may disappear or be much lessened just before death. In 1 case of probable tubercular meningitis, it was present in one leg, but not in a typical manner in the other. He examined 25 healthy individuals, in all of whom the sign was absent. In 100 cases of various troubles, the Kernig was present in only 2, 1 a gonorrhœal rheumatism of the knee, the patient having remained in bed with the legs flexed for several weeks, the other a subdural hemorrhage.

Netter has published two series of cases of meningitis, in all 72 in number, with positive Kernig in 91 per cent. In 1 of the negative cases the child had an advanced tuberculosis, in another the test was made only once.

Friis, of Copenhagen, in 1887, reported it present in 53 out of 60 cases. In 2 of the negative cases the test was doubtful, in 3 the examination could not be properly made, and in 2 it was absent.

In a later series in 1892, all of which were of the epidemic type, it was present in 21 out of 26 cases. He considered that there was no relation between the sign and the rigidity of the neck.

Bull found the sign present in a case of tuberculous meningitis, in a solitary tubercle of the cerebellum, with a few miliary tubercles in the overlying pia, and in a case of otitis media, with thrombosis of the transverse sinus and basal ecchymosis.

Blumm reports it present in 7 out of 9 cases of cerebrospinal meningitis.

Thyne, in a case with hemorrhage into the right lateral lobe of the cerebellum and the fourth ventricle.

Packard reported several negative cases: 1, a child, aged sixteen months, with general miliary tuberculosis, the membranes of brain and cord being involved, where daily examination gave negative results. In a second case of leptomeningitis following pneumonia, the sign was always absent. In a third case with miliary tubercles over the motor area of the cortex, repeated examinations were negative. He did not attach much importance to the sign in infants.

Magri refers to cases where, in uncomplicated typhoid and pneumonia, the sign was present, and to a case of his own where the patient had sciatica.

Sailer found the sign present in a case of focal encephalitis of the ascending parietal lobe with the overlying meninges congested, and in a patient where the diagnosis of unilateral lesion of the medulla was made.

Clark, in 2 cases of tubercular meningitis, never found the angle less than 150 degrees, and the sign was absent in a case of acute cerebrospinal meningitis of undetermined bacterial nature, where there was marked exudate over the thoracic cord.

Rudolph, by means of an instrument, measured the angle in 162 cases, found it less than 180 degrees in 60 per cent. of cases; 165 degrees or less in 0.4 per cent.; 135 degrees or less in 6 per cent. As above mentioned, his method was to measure the angle at the hip. Shields measured the angle in 100 cases, both febrile and afebrile, and in 5 found an angle of 120 degrees or less. Two of these were typhoid; in 1 unilateral, 100 degrees; the other bilateral, 110 degrees. In the former it did not disappear during convalescence. One case of uræmia, angle 110 degrees. The other 2 were hemiplegics, with angles of 115 degrees and 120 degrees respectively.

My own observations were confined chiefly: first, to acute infections—mainly typhoid and pneumonia; second, various forms of meningitis; third, central and peripheral nervous troubles; fourth, patients who had been confined to bed for several weeks, chiefly convalescents from acute infections and surgical cases. The material was obtained from the Cook County Hospital. The angle was measured by means of an inclinometer, an instrument of accuracy. On account of the irregular contour of the parts, it is, of course, impossible to obtain very exact measurements, even with an accurate instrument. All the tests were made with the patient in the dorsal position. The thigh was first placed at right angles to the trunk, then the leg was extended on the thigh until it either caused pain or could not be farther extended without using considerable force. Babinski's reflex was observed in most of the cases, and the results of this test are placed in the table.

In none of the cases examined was there an angle of 180 degrees, and in several healthy individuals it was impossible to obtain this angle without either allowing the thigh to recede from its position at right angles to the trunk, or using sufficient force to cause discomfort, the average angle being about 165 degrees.

An angle of 115 degrees or less has been considered a positive Kernig. This I believe is better than 135 degrees, as suggested by Kernig, as it excludes very few cases of meningitis, and an angle of 135 degrees is not infrequent in other conditions. A bilateral test was made in all cases. In the following table are summaries of the results:

Disease.	Total cases.	Kernig presents 115° or less.	Angle 120°.	Angle 125°.
Typhoid	48	4	5	9
Transverse myelitis	4	1		
Hemiplegia	17	7	2	2
Syphilitic spastic paraplegia	7	4	1	
Primary spastic paraplegia	1	1		
Carcinoma of spine	1	1		
Infantile paralysis	1	1		
Multiple neuritis	16	3	3	3
Sciatica	12	2	1	1
Delirium tremens	3	1		
Hysteria	3	...	...	1
Tetany	1	1		
Uræmia	2	2		
Illuminating-gas poisoning	1	1		
Cerebrospinal meningitis	6	4	1	
Tuberculous meningitis	3	3		
Diplococcus pneumoniæ meningitis	1			
Cerebrospinal syphilis	4	3		
Thigh fracture	3	1	1	
Pneumonia	22	3	...	5
Locomotor ataxia	6	1		
Lumbago	1			
Pericarditis	1			
Tetanus	1			
Status epilepticus	1			
Chronic chorea	1			
Acromegaly	1			
Paralysis agitans	4			
Syringomyelia	1			
Multiple sclerosis	2			
Typhoid spondylitis	1	...	...	1
Landry's paralysis	1			
Trichinosis	2	...	1	
Gonorrhœal myalgia	2			
Progressive muscular atrophy	1			
Amyotrophic lateral sclerosis	1			
Brain abscess	1	...	1	
Surgical cases exclusive of thigh fractures	8			

A Kernig was present in 45 of the 190 cases. Four of the 10 cases of meningitis failed to give the reaction, although 1 of these had an angle of 120 degrees. This was an epidemic cerebrospinal. One epidemic cerebrospinal had an angle of 150 degrees in the second week. The other negative cases were 1 each of pneumococcus and tuberculous meningitis, the latter giving an angle of 125 degrees. Strictly speaking, in only 2 cases of meningitis was there an absolute absence of the Kernig sign. In 1 of the cases the sign only appeared late, several days after a lumbar puncture, demonstrating the specific micro-organism. The diagnosis in all of these cases was verified either by lumbar puncture or autopsy.

Positive results were obtained in 7 of the 17 hemiplegias, and 4 others had an angle of 125 degrees or less. The sign was bilateral in 4 cases. One of these proved to be a hemorrhage into the ventricle. One was a double hemiplegia, with an interval of several weeks between the attacks. The other 2 were apparently uncomplicated hemiplegias, with no especial evidence indicating a ventricular or basal meningeal process.

Seven cases of Erb's syphilitic spastic paraplegia were examined: 4 gave the Kernig bilaterally, 1 had an angle of 120 degrees, the other 2 were completely negative. A case of primary spastic paraplegia was positive.

Of interest is the positive test in 3 of 16 cases of multiple neuritis, and 3 cases with an angle of 120 degrees, and 3 with an angle of 125 degrees. The sign was bilateral in all the cases. The majority of the cases examined were of several weeks' standing; 1 of the positive was of two months' duration, another one week. Only 3 cases of this series had an angle greater than 145 degrees.

Twelve sciaticas were examined, with 2 positive results. One of the negative cases had an angle of 125 degrees; another 120 degrees. The positive cases were both of a severe type. The patient with an angle of 125 degrees had a very mild attack.

Several have reported the sign present in uræmia. Only 2 cases were examined for the sign, and both were positive; 1 bilateral, the other unilateral.

Three out of 4 cases of cerebrospinal syphilis gave a bilateral positive test, the other was completely negative.

With a view of ascertaining whether the sign might develop in patients who had been confined to their bed for several weeks, the uninjured extremity in 3 cases of thigh fracture was examined, with 1 positive result and 1 with an angle of 120 degrees. Two patients who had been in bed for three weeks following a herniotomy were negative. Two patients in bed for four and six weeks, respectively, with fractured ribs were negative.

The pneumonias examined were the severe cases that entered the hospital. In all 22 cases were tested. Three gave a positive Kernig, 5 gave an angle of 125 degrees, and the remainder were negative. In those who gave the test there were no signs or symptoms of meningitis. The typhoids examined included those in the active stage of the disease and convalescents—the latter for the purpose of determining whether a prolonged stay in bed was a causative factor in the sign. In all 48 cases were examined: 4 were positive, 5 had an angle of 120 degrees, 9 an angle of 125 degrees. Twenty-four were in the active stage of the disease, 19 of these at least moderately severe cases. None of these gave a Kernig, all of the positive cases being in the convalescents. Those giving an angle of 120 degrees, 5 in number; 3 were in the active stage of the disease, 5 convalescents. Those giving an angle of 125 degrees, 5 were in the active stage of the disease, 4 convalescents. Only 1 of the convalescents had lain in bed with the knees drawn up.

Two cases of trichinosis were examined. In both of these the diagnosis was confirmed by finding the unencapsulated parasite in a piece of excised muscle and by the presence of an eosinophilia. One patient was in the very acute stage with intense muscular rigidity and soreness, sufficient, at least, to suggest a meningeal process, and the angle was 120 degrees. The other patient was in early convalescence, and the sign was negative.

The patient with the illuminating-gas poisoning died, and, as an autopsy was not obtained, it would be impossible to exclude a chronic cord or cerebral lesion which might have been responsible for the sign.

The results of these tests agree quite well with the investigations of others, and Henoch was first to call attention to the unreliability of the sign. Its frequency in other conditions, some of which may resemble meningitis, as an illustration, trichinosis and uræmia, lessen its diagnostic value. Its not infrequent absence in meningitis, especially in the tubercular form, and its often late and transitory appearance, lessens its significance. On account of its late or transitory appearance, daily or at least repeated examinations should be made. The presence or degree of sign is no index of the severity of the symptoms or gravity of the case.

Several theories have been advanced to explain the cause of the Kernig phenomena.

Netter considered that on account of inflammation the roots of the spinal nerves were irritated, and in extending the leg on the thigh the sacral nerves are stretched, causing reflex contraction of the flexors.

Friis suggested it was due to irritation of the cauda equina by the infected cerebrospinal fluid.

Chauffard considered it an exaggerated normal phenomena due to hypertonicity of the muscle.

Sailer would explain the sign by an irritative lesion of the pyramidal tract that diminishes but does not destroy its functional activity.

Rudolph believes the increased muscular tone, probably due to cerebellar irritation, is responsible for the sign in meningitis, and that recumbency may be the cause in some cases.

Several have explained the phenomena by increased intracerebral pressure, but Roglet's experiments show that in animals increased intracerebral pressure does not cause a muscular contraction of this nature. Rudolph reports slight decrease in the Kernig after spinal puncture.

From a clinical standpoint, it would appear that the various disease conditions in which the sign may be found excludes the probability of a common origin. Netter's view of nerve irritation might explain its frequency in meningitis, neuritis, and sciatica. Pyramidal-tract involvement offers the most plausible explanation of its presence in hemiplegia and spastic paraplegia.

Babinski's reflex was examined in most cases, in quite a number of patients contractions either negative or positive could not be obtained. In those who gave a positive reaction, repeated tests were made in order to be certain the reaction was not accidental, and any case that showed a single plantar flexion was classed as negative. In 17 cases of hemiplegia 11 gave a positive reaction, 5 negative, and 1 not tested. A case of illuminating-gas poisoning gave a typical positive reflex. As the patient died, we were unable to exclude a possible pre-existing cord lesion. Two typhoids gave the reflex; it differed, however, from the cases with lateral tract involvement by being slow and of very moderate degree, but always getting a dorsum flexion; neither of these cases had any other signs of involvement of the lateral tract. One of 4 cases of cerebrospinal syphilis was positive, and it is not improbable that the substance of the cord was involved. One case of gonorrhœal myalgia gave a slight positive reaction. A case of progressive muscular atrophy without any other signs of lateral-tract involvement gave the test in a very typical manner. The reaction was characteristic in a case of amyotrophic lateral sclerosis. One of 4 cases of transverse myelitis gave a positive test, and 1 case of carcinoma of spine. Seven of the 8 cases of spastic paraplegia were positive.

SUMMARY. 1. A maximum angle of 115 degrees gives more valuable results than does an angle of 135 degrees, as proposed by Kernig.

2. The angle obtained in any individual case depends, in part, upon the force used in extending the leg, and for this reason actual measuring of the angle is not essential.

3. The sign is present in a large percentage of the cases of meningitis; it is, however, not constant, may be transitory, or only appear late; therefore, daily examination should be made for its presence.

4. It is present in a typical manner, occasionally in a number of widely different disease conditions, and for this reason it is probable that there is not a uniform cause for the sign.

5. The sign is occasionally unilateral, exclusive of cases of hemiplegia or local trouble, which might explain its unilateral presence.

6. The presence of the sign in cases of suspected meningitis is merely another factor favoring the diagnosis. Its absence, especially early, is not infrequent, and should not be allowed to outweigh the positive findings.

BIBLIOGRAPHY.

Kernig. Berlin klin. Woch., December 29, 1884.
Osler. Lancet, June 24, 1897.
Rudolph. American Medicine, November 8, 1902.
Friis. Copenhagen Thesis, 1887. Quoted by Netter.
Herrick Journal of the American Medical Association, 1889, p. 85.
Netter. La semaine médical, 1898, p. 281.
Bull. Berlin. klin. Woch., 1895, p. 772.
Blumm. Münch. med. Woch., 1889. p. 446.
Thyne. Lancet, 1901, p. 397.
Packard. Archives of Pediatrics, April, 1900, p. 259.
Magri. Cent. f. innere Med., No. 46.
Sailer. THE AMERICAN JOURNAL OF THE MEDICAL SCIENCES, 1902.
Clark. Ibid.
Chauffard. La presse médical, 1901, p. 153.